UNCLASSIFIED

Defense Technical Information Center Compilation Part Notice

ADP023032

TITLE: Self Assessment of Advanced Shipbuilding Technology Implementation

DISTRIBUTION: Approved for public release, distribution unlimited

This paper is part of the following report:

TITLE: Proceedings of the Ship Production Symposium, held in New Orleans, Louisiana, on 2-4 September 1992

To order the complete compilation report, use: ADA455880

The component part is provided here to allow users access to individually authored sections of proceedings, annals, symposia, etc. However, the component should be considered within the context of the overall compilation report and not as a stand-alone technical report.

The following component part numbers comprise the compilation report:
ADP023023 thru ADP023050

UNCLASSIFIED

THE SOCIETY OF NAVAL ARCHITECTS AND MARINE ENGINEERS
601 PAVONIA AVENUE, JERSEY CITY, NJ 07366
Paper presented at the NSRP 1992 ship Production symposium,New Orleans Hyatt Regency. New Orleans, Louisiana September 2-4.1892

Self Assessment of Advanced Shipbuilding Technology Implementation

No. 3B-3

Walter L. Christensen, Member, presentation also by Louis D. Chirillo, Fellow, Bellevue, Washington, Stephen Maguire, Member, Avondale Shipyards, Inc., and Anthony Gambello, Visitor

ABSTRACT

This report lists and describes ten factors and associated evaluation criteria which can be used to assess the degree of implementation of advanced shipbuilding technology in a shipyard.

If the U.S. shipbuilding industry is to improve its competitive position in the global shipbuilding market it must move more quickly and agressively to implement productivity initiatives. To this end, two recommendations are presented at the conclusion of this report.

ACRONYMS

- PWBS: Product Work Breakdown Structure
- SWBS: System Work Breakdown Structure

INTRODUCTION

The NAVSEA Shipbuilding Support Office (NAVSHIPSO) was tasked during fiscal year 199 1 to develop candidate factors and supporting elements which can be used to quantify the degree of implementation of advanced shipbuilding methods by a shipyard.

BACKGROUND

Most of the Navy's existing cost estimating methods for shipbuilding are oriented to the Ship Work Breakdown Structure (SWBS) which is system and weight dependent. Ship construction Cost Estimating Relationships (CERs) are derived from historical data reflecting past accounting methods and performance (i.e., return costs) of particular shipyards. However, shipbuilding practices and methods are undergoing very substantial changes. Cost reductions resulting from newly adopted and developing shipbuilding technologies and production methods are not reflected in the existing historically based cost estimating techniques. Advanced shipbuilding technologies typically involve a modular, product oriented approach which cuts across elements of the existing SWBS. Thus, even the basic structure of the current approach to ship cost estimating is of questionable relevance for modeling the ship construction processes and cost estimates of the future.

Further, if the Navy is to have available a shipbuilding infrastructure/ mobilization base for affordable ships in the future and for surge requirements, the Navy might benefit from understanding and encouraging ongoing and future transformation projects at the shipyards. Currently, such encouragement is largely limited to cost-sharing of the National Shipbuilding Research Program (NSRP), under the Navy Manufacturing Technology Program. The Navy's ability to encourage might be greatly enhanced by a plan for shipyard transformation that represented a consensus view of shipyard managers. A consolidated plan might provide guidance to the Navy in its efforts to break down barriers to more efficient shipbuilding (some of which the Government has created, and only the Government can dismantle).

The immediate goal of this self-assessment survey is to :

- Provide a draft transformation outline for discussion and further development by the shipbuilding community.

Longer range goals of this self-assessment survey are to :

- Provide Navy cost analysis tools which quantify the most significant cost drivers of current and proposed (advanced) ship construction techniques. This should result in more accurate cost estimates for budgetary purposes.

- Enable the Navy's naval architects and marine engineers to modify ship design processes to best support advanced shipbuilding technologies and production methods.

  Provide a basis for development of Navy projects to encourage shipyard developments and to remove barriers thereto.

TRADITIONAL PRACTICES ARE DIFFICULT TO CHANGE

"Just give us the plans and material on time and we can build ships as productively as anyone." So say traditional production bosses. Nothing could be further from the truth, because a critical element is missing. Managers of the world's most productive shipyards have succeeded in getting their production people highly involved in design matters starting with development of detailed, working plans. Thus the entire design effort reflects and supports a premeditated building strategy for integrated hull construction, outfitting and painting; design is truly an integral part of planning. Additionally, compared to traditional shipyards, the organization of people, information and work processes in the most productive shipyards are interdependent and comprise constantly self-improving shipbuilding systems (1).

TRADITIONAL PREOUTFITTED MODULAR CONSTRUCTION VERSUS ADVANCED SHIPBUILDING TECHNOLOGY

Some shipbuilders think preoutfitted modular construction constitutes implementation of advanced shipbuilding technology. This is only partially true. The world's most productive shipyards use a planning methodology which organizes work, people, facilities and other resources so as to drive the process towards highly efficient, prod: uct oriented ship construction methods (including preoutfitted modules) and away from system oriented ship construction methods which are less effrcient and less manageable.

Traditional preoutfitting of hull blocks (modules) divides installation work into two basic stages; on-block and onboard. However, many shipbuilders continue to employ system-by-system installation drawings followed by relatively large work orders that specify preoutfitting work by systems or pok tions of systems. These large, unsequenced work packages complicate attempts to achieve uniform and coordinated work flows. They often result in work teams competing with each other for access to work sites and in poorly sequenced installations which must be reworked.

No less illogical, people who perform detail design, material definition and material procurement system-by-system are often unnecessarily preoccupied with portions of systems that will not be required for some time. Detail design and material definition, both vital aspects of planning and material procurement, are system oriented, whereas preoutfitting is geographically oriented. Under such circumstances, the efficiency of even comprehensive preoutfitting is limited because of the inherent conflicts between the planning, design, and build strategies.

Efforts to avoid these conflicts and improve productivity compelled the Japanese shipbuilding industry to focus on a single, integrated product-oriented strategy which, in turn, led to the development of modem scientific shipbuilding methods.

EVALUATION CRITERIA TO ASSESS DEGREE OF IMPLEMENTATION

This section explains criteria used to develop the self-assessment form, Table I.

Group A - Business & Management

The business and management group consists of basic requisites for any business activity to be viable. It must be readdressed in light of the significant changes necessary to improve productivity. The group consists of factors 1 and 2 below, which must be implemented in the sequence shown in order to assure the success of the manufacturing process improvements outlined in Groups B and C which follow. Group A factors are mandatory prerequisites to a successful transition to product oriented ship construction and, although measurable, do not quantitatively contribute to improved productivity.

Factor 1 - Business Plan. The criteria in the business plan factor are leading indicators of a shipyard's ability to be globally competitive. Unless a corporation is committed to be a world class shipbuilder and structures its financial and marketing strategic plans accordingly, it will probably not succeed in the international shipbuilding market. Failure internationally will lead to closure in many cases, because Navy and domestic commercial orders will not sustain current levels. Conversely, success intemationally could improve the domestic situation due to improved affordability. Additionally, if the corporation's top management does not recognize that a significant portion of its procedures consist of non-process and non-value added waste, and does not include appropriate items in its business plan to reduce that waste, (i.e. productivity improvement initiatives) it will not become competitive in the global market.

Factor 2 - Leadership And Management. Once management decides what market it wants to participate in, it must develop a strategy that drives the corporation towards the productivity improvements of product oriented ship construction methods. To do this, top management must show lower level managers that they will not deviate from implementing these best proven methods. Top management's commitment to implementing product oriented ship construction methods must constantly be visible to the entire corporation.

Management must address the fact that approximately SO%-90% of process problems are caused by their system rather than their workforce and take responsibility for solving their system-caused problems. Human dynamics requires that human roadblocks and passive observers be converted into supporters of changes that are being implemented.

Group B - Product Oriented Process Technology

This group addresses improvements in organization of work, resources and processes which measurably affect productivity. The generic steps required to establish and maintain an environment for long term improvement are:

1. organize work according to group technology,
2. organize and schedule resources into work flows that embody group technology,
3. categorize functions, (e.g., design, material definition, material procurement, and types of work) that affect the work flows,
4. reorganize so that lines of authority and accountability reflect the requirements of group technology, and
5. implement statistical process analysis. This is the reason for implementing group technology in the first place! If a shipyard is not committed to continuous improvement process via statistical analy-

sis, there is no reason to group work more scientifically than it is already done (i.e., most yards already group work by craft, by common tooling requirements, other simple measures).

Croup B consists of factors #3, #4, and **#5,** below, which must be fairly well implemented in sequence, leading to statistical analytical methods.

Factor 3 - Product Work Breakdown Structure (PWBS). PWBS is a common language used to organize work. Early identification, procurement, and scheduling of long lead time material (LLTM), resources (manning, site and equipment availability) and interim products, allows efficient organization of work emphasizing group technology and manufacturing resource categorization. LLTM can be identified and ordered from building specifications and contract plans. Combined, early efforts by production, planning and design personnel using PWBS, allows definition and development of interim products which are designed for production, thus facilitating the integration of product oriented outfitting with structural assemblies (blocks). The result is realistic schedules and manpower estimates. Completely pre-outfitted modules do not necessarily represent a well planned construction project.

This paper uses a broad interpretation of group technology when it refers to PWBS. Interim products have a volumetric flavor during fabrication. A Process Work Breakdown Structure might better describe the interim products during installation. And finally, a System Work Breakdown Structure might be most appropriate to control interim products during system testing.

Factor 4 - Process Lanes. Process Lanes is the embodiment of a Product Work Breakdown Structure, in that it organizes people, facilities, tooling and other resources to suit PWBS. It categorizes and assigns "like" kinds of work to specifically designed "work centers" in order to benefit from "learning curve" and "assembly line" type efficiencies which result from having the same people do the same type of work every day, at the same location, with a constant organized flow of material.

The goal is a process that operates predictably, can be analyzed via statistics, can have small group improvements (because the statistics let the workers freely discuss problems), and continuously improves. None of this can be accomplished if a "work center" is processing a haphazard variety of dissimilar interim products!

When Process Lanes are established, detailed Process Lane schedules are developed based on volume and capacity of each work center. Management can then closely monitor work center cost and efficiency, and identify and correct "like" problems (i.e., reduce rework costs) at a specific location. But, if total throughput is not increased, or operating cost (manning) reduced, or this work center is not the bottleneck, there will not be a significant improvement!

Factor 5 - Statistical Process Analysis. Once work and resources are organized in a logical way to produce products by problem area by stage, immediate feedback of statistical information from the worker and his/her supervisor within their sphere of influence is made possible. This allows the use of statistical and analytical methods to produce immediate feedback to the worker and his or her supervisor on progress and quality.

Group C - Iterate Process Refinements

Once statistically based analytical processes and methods that have been successful in creating constant and somewhat self-managing systems which foster a continuous learning and self-improvement process, iterative im-. provements can be implemented at strategic locations throughout the process train. The preceeding steps (Group A and Group B) must have been implemented and be reasonably underway for this technology area to be useful.

The following factors provide a sample of significant initiatives that can be undertaken after successful implementation of Groups A and B. These factors in Group C can be worked in any order. Other factors can be added, as appropriate.

Factor 6 - Quality Of Support Spiral. This area provides information which allows accurate cost and schedule estimates and controls. It is a continuous loop that inputs feedback from the people who do the work (production, mated rial definition, material procurement, etc.) into the planning and control efforts. A rigid, tightly, structured feedback system makes inaccuracies in schedule aud manpower estimates more visible. As work processes become more accurate and work packages become better defined, standardized work packages evolve that are used to improve work estimates. Later, as statistical and analytical processes are used, labor (man-hours) can be equated to a measurable entity of material (called parametric-component weight). This ability allows more accurate scheduling, progress reporting, bid estimating, and assessment of change order impacts.

Factor 7 - Small Group Activities. This area creates a system of constant, gradual (incremental) and continuous improvement by everyone. Some writers refer to this as “team culture.” It is not “quality circles” as misapplied by many U.S. manufacturing industries several years ago. First, work must be rationalized. Then, appropriate and meaningful data must be made immediately available to the worker within his or her sphere of influence. Next, management-caused problems must be separated from worker-caused problems. Following this, management must respond and correct the management-caused problems. When it is obvious to workers that these problems are being corrected, they will continuously respond with spontaneous, incremental improvements among themselves. This constant, never-ending process will result in daily improvements. At the end of a year the total improvement can be impressive.

Factor 8 - Design Refinements via Process and Customer Feedback and Factor 9 - Manufacturing Accounting System. Like factors 6 and 7, these two factors can be started concurrently. At this point an organization is operating in a much more productive manner.

Group D - Hard Technology

This group recognizes the need to include modem manufacturing technology in any studies and programs relating to the implementation of advanced shipbuilding technology in any shipyard. The value of larger cranes, faster automated equipment, robotic machinery, computer aided design (CAD), computer aided manufacturing (CAM), computer integrated manufacturing (CIM), etc. has been, and continues to be, studied by the National Shipbuilding Research Program.

Factor 10 - Facilities, Equipment and Automation. The benefits resulting from facilities and equipment improvements, and automation are significant, however they cannot be extracted and evaluated since they are integral to the process itself. This factor is included in this report to assure its continued consideration in future productivity improvement studies.

If implemented prior to Groups A, B, and C above, a shipyard is paying lots of dollars for a robot that can do the wrong thing faster and better, or to replace non-value-added work that should not be there anyway and is a symptom of bad management and a system that is out of control!

CONCLUSIONS

The degree of implementation of Advanced Shipbuilding Technology in U.S. shipyards varies considerably and is not very high. Also, it was observed that continued implementation of initiatives at most shipyards has either ceased or is progressing at a very slow rate. This is unfortunate because it has been estimated , in testimony given to the Commission on Merchant Marine and Defense, that replacing traditional shipbuilding methods with advanced shipbuilding techniques at U.S. shipyards would result in cost savings up to 40%. In addition, the world's leading shipyards are quoting significant schedule savings.

It comes as no surprise, therefore, that the U.S. shipbuilding industry is not competitive in the world market, and, as a result, market share of world ship construction and repair contracts is woefully small. Obviously, something is wrong (Maybe many things are wrong.) This is not intended to be an indictment of the shipyards alone. It should be recognized that many of the shipyard management systems that have been developed in response to Navy requirements may be creating barriers to the shipyard's transformation process.

It is imperative that the Industry move quickly to implement measures to reduce our shipbuilding/ship repair costs, shorten our building schedules and improve our quality. Similarly, the Navy needs to continue in its ongoing efforts to identify and eliminate barriers to long-term success of its shipbuilding supplier base. The Japanese have reached these goals by the introduction of advanced shipbuilding methods (product oriented ship construction) to their industry. The U.S. shipbuilding industry must mimic (and hopefully improve) their processes if we are to survive.

RECOMMENDATIONS

Concerned organizations such as the National Shipbuilding Research Program (NSRP), Society of Naval Architects and Marine Engineers (SNAME), American Society of Naval Engineers (ASNE), Shipbuilders Council of America (SCA), et al, should develop and pursue initiatives to expedite implementation of advanced shipbuilding methods in American shipyards. Among the early initiatives it is recommended that:

a) a structured educational program be developed to assure all shipyards understand the principals of product oriented ship construction and the potential benefits resulting from its implementation, and

b) a strategy be developed to assist shipyards in making the transition from current shipbuilding practices to improved shipbuilding practices (i.e., from system to product oriented design and construction). The strategy should address the problems inherent with the existence of two management systems simultaneously, (one for each shipbuilding practice), and means by which this unwieldy and inefficient (but temporary) situation and its problems can be handled until eventually only one management system exists. However, there may continue to be elements. Financial aid (perhaps in the form of temporary government subsidies) should be addressed, as a possible source of funds to absorb "one time" transition costs.

ACKNOWLEDGEMENTS

This report is dedicated to improving shipbuilding as U.S. shipyards struggle to implement advanced technologies to improve shipbuilding costs, schedules, quality, customer satisfaction and international market share. Much of the material comes from countless writings and personal conversations with Lou Chirillo of L.D. Chirillo Associates and Steve Maguire of Avondale. Other contributors are RADM Robert Traister, USN (NAVSEA 91); Ed Kinney (SEA 05B, ret.); Professor Richard Starch (U.

of Wash.); Don Spanninga, Pete Jaquith, Lyn Haumschilt, Jay Carson, A.G. Par&h, Bill Wilson, and James Royle of NASSCO; Ellsworth Peterson and Gary Higgins of Peterson Builders; J.R. Phillips, Steve Buttner, Jeffrey Tarbox, James O'Hare and Mark McAuliffe of Bath Iron Works; Norman Augustine of Martin Marietta; David Bergeron of Avondale; Paul Albert of McDermott; Jess Brasher, Bob Slaughter and Tom Rakish of Ingalls; CAPT Bill Kerr, USN (ret), Bill Jordan, Bill Anast, LCDR Mark O'Hare, USN, LCDR Larry Burrill, USN, LCDR Mark Peterson-Overton, USN and LCDR Larry Baun, USN of the Philadelphia Naval Shipyard; CAPT Dennis Kruse, USN and Bill Boylan of NSWC; Dr. Jeffrey Gren of the International Trade Administration; Frank Rack of the A.Y. Goldratt Institute; Robert Guastini, George Trausch, Scott Waring, and Michael Mannix of Electric Boat; Hideo Nakai of IHI; Perry Nelson of M. Rosenblatt; Virgil Rinehart of MarAd; Ray Ramsay of Politech Services International; Rodney Robinson of RPM; Bill Humphrey of DAI; David Woods of Office of Naval Technology; John Stocker of the Shipbuilders Council of America and Professor Howard Bunch, and Karla Karinen of the U. of Mich.

3(l) Lou Chirillo, private communication, 1991.

The views expressed herein are the opinions of the author and not necessarily those of the Department of Defense, the Department of the Navy, the Naval Sea Systems Command, the NAVSEA Shipbuilding Support Office or any other person.

Table I. - Self-assessment of Advanced Shipbuilding Technology Implementation

GROUP / FACTOR	Degree of Implementation: Individual Element	Total Factor	Weight Factor
Group A : Business and Management			
Factor 1: Business plan			
1a Long term commitment (to producing quality, affordable products; to customer needs; to development of human resources; to sound business practices; to long term decision making, etc.).			
1b Strategy for marketing (diversified and responsive system, but limited to a few 'niche' products at any one time).			
1c Extraordinary marketing effort.			
1d Draft future structure to guide transformation (PWBS in accordance with group technology, manufacturing accounting system, continuous improvement process).			
1e Strategy for productivity improvement (including a schedule for implementation).			
Factor 2: Leadership and Management			
2a Top Management understands the business plan and directs its implementation.			
2b Human dynamics addressed by the top manager.			
2c Organization structured to be responsive to business plan, customer needs, & production technology transformation.			
2d The top manager continuously demonstrates commitment.			
2e The top manager participates in selection of productivity improvement projects, etc.			
2f The top manager monitors the progress of productivity improvement projects etc.			
Group B: Implementation of Group Technology			
Factor 3: Product Work Breakdown Structure (PWBS)			
3a Categorize work by PWBS (by sameness of problem areas inherent in their manufacture.			
3b Produce product schedule based on PWBS.			
3c Integrate schedules with production (have production verify manning and space availability).			

Factor 4: Process Lanes

4a Plan & schedule work by PWBS.
4b Group production resources to match PWBS assignment by problem category.
4c Group design, planning, and other support resources, where appropriate, to match production groups.
4b Establish decentralized, hierarchial planning, scheduling, & control.

Factor 5: Statistical Process Analysis

5a Implement top management policy & follow through.
5b Establish process requirements for cost, schedule, & quality.
5c Start measuring process variables.
5d Train workers in problem solving techniques: x bar & R charts, cause & effect diagrams,Pareto analysis, etc.
5e Identify unique vice systemic problems, special vice common problems.
5f Establish a database for long-term analysis & establish goals for continuous improvement.

Group C: Iterate Process Refinements

Factor 6: Quality of support spiral

6a Implement a structured system which provides regular feedback of quality, schedule adherence, & manpower expenditures.
6b Enlist users to be an integral part of the planning, scheduling, measuring, and reporting efforts.
6c As quality, cost and schedule performance improve, use feedback to develop standardized interim product work packages.

Factor 7: Small Group Activities

7a Rationalize work. First, ensure product work breakdown structure and process lanes are implemented for applicable groups.
7b Analyze problems statistically. Make information of work performance immediately available to workers & identify problems. This distinguishes the 85% of management-caused problems from the worker-caused problems.
7c Workers recommend improvements. Management responds.
7d Workers implement improvements. Management supports improvements & perpetuates cycle.

Factor 8: Design Refinements via Process & Customer Feedback

8a Analyze PWBS/process lanes data & determine optimal interim product standardization.

8b For non-standard products, develop opportunities for optimal process lanes utilization.

8c Utilize structured process to solicit customer feedback.

8d Translate above feedback into design refinement via continuous improvement process.

Factor 9: Manufacturing Accounting System

9a Implement system that complements flexible production system & promotes reductions in process time/in-process material, that facilitates management decision making in new manufacturing philosophy, & that promotes long-term customer-oriented planning.

Group D: Hard Technology

Factor 10: Facilities, equipment & automation

The benefits resulting from facilities, equipment & automation can be significant; however, they need to be analyzed in context of production transformation.

Their return on investment will be maximized only after process flows are stable & well understood.